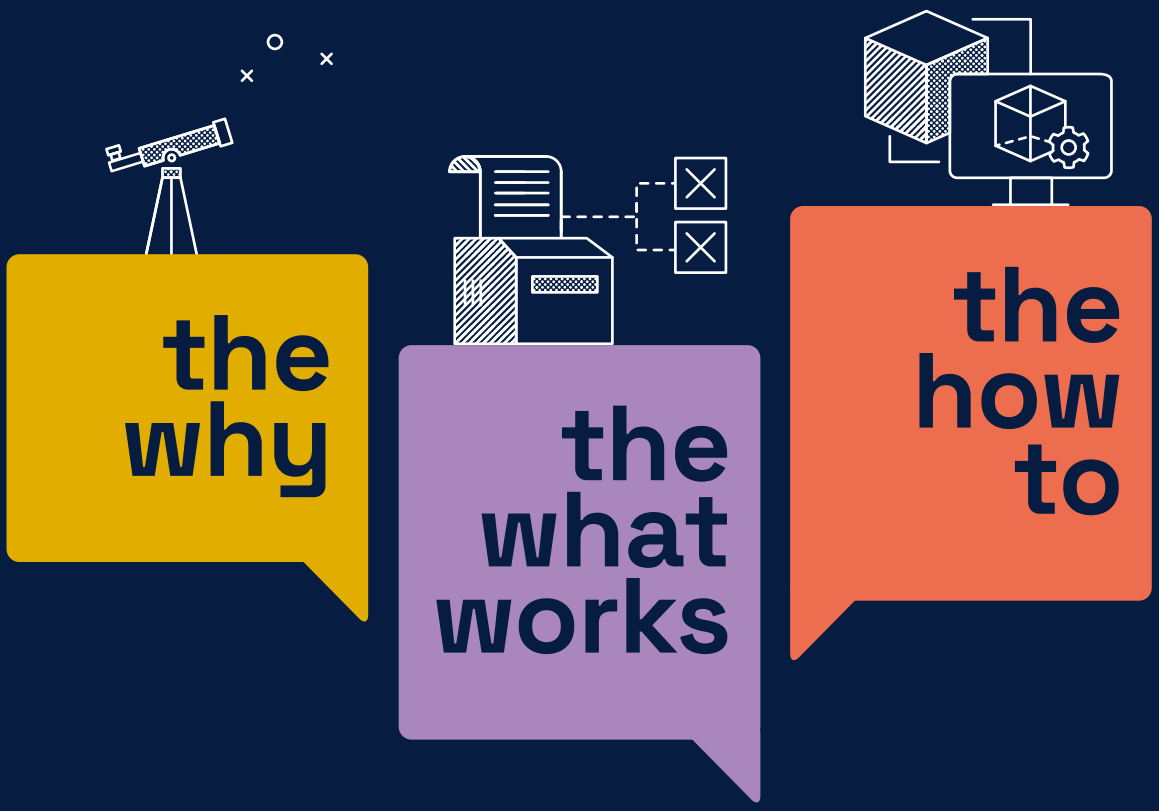
CHALLENGE WORKS
by nesta



11 Challenge Works' 10 Must-Reads on Prizes

Summarising key evidence on the role and use of prizes to incentivise innovation

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L1 Challenge Works' 10 Must-Reads on Prizes

Summarising key evidence on the role and use of prizes to incentivise innovation

Challenge prizes offer a reward to whoever can first or most effectively solve a problem. They are a proven tool to spur innovation, but designing and managing them requires skill and good governance. The academic literature on prizes is wide, ranging from economic theory to studies of historical competitions. For individuals and organisations new to challenge prizes, it can be hard to know where to start.

That's why Challenge Works have gone through the external research and selected these 10 articles as some of the most important to help you understand the arguments and evidence. It aims to support the effective use of prizes by helping you:

For those thinking about how best to tackle their innovation problem, these insights will hopefully help you understand the key dynamics of challenge prizes and maximise the impact of your funding.

- Understand when a prize might be a better option to a grant or patent – especially when you can define a clear goal but the pathway to reaching it is uncertain
- Design challenges that lower barriers to entry for unconventional entrants
- Learn how non-financial incentives are important drivers of performance in prizes
- Design rules that manage uncertainty while still encouraging creativity
- Consider how to structure prize governance to build trust and legitimacy

The must-read papers have been organised into three areas: the economic rationale; the empirical evidence of what works; and practical guidance on design and implementation.

1 Introduction

Challenge prizes, defined as a reward to whoever can first or most effectively solve a problem, are one of the oldest forms of innovation policy.

Challenge prizes, defined as a reward to whoever can first or most effectively solve a problem, are one of the oldest forms of innovation policy. Their use by governments and institutions to stimulate innovation breakthroughs dates back centuries, famously exemplified by the 1714 Longitude Prize, which spurred critical advances in naval navigation – and which has since led to a programme of Longitude Prizes to address the critical needs and priorities of society. Whilst the popularity and use of challenge prizes fell in the early 20th century, owing largely to the institutionalisation of the patent system and the rise of R&D grants, prizes have experienced a significant resurgence since the 1990s, driven by growing government interest (the introduction of the America COMPETES Reauthorization Act in the U.S. provided all federal agencies with authority to conduct prize competitions, whilst the UK government has recently trialled prizes to spur innovation in AI via the Manchester Prize and in open data through the Smart Data Challenge Prize) and philanthropic efforts.

The case for challenge prizes lies in their unique attributes and ability to correct specific market failures. In terms of key attributes, prizes set clear objectives without specifying the technical approach to achieve the goal. This freedom in approach helps to attract a diverse range of unconventional or unusual innovators – which, in turn, enables the discovery of high-value outcomes. As prizes only pay for results, they provide a mechanism for efficiently focusing multiple actors and resources on a common problem and they leverage external investment, often drawing in capital multiple times the prize purse amount. These attributes, amongst others, make them particularly valuable for tackling challenges characterised by market failure, where the pathway to success is unclear or uncertain, and / or where established solutions have stalled.

In economic terms, prizes are a key example of a pull mechanism – a funding mechanism that rewards outputs and outcomes. This structure minimises the funder's risk because they only pay for the final success.This also means the funder doesn't have to estimate how much the research will cost or exactly how the innovators should proceed – instead, innovators, who know their methods and costs best, can determine what they think is the best way forward and the risks associated with any such approach. Critically, prizes are adept in correcting specific market failures where competitive markets fail to provide adequate incentives, such as when the social value of an innovation exceeds its commercial profits. Unlike grants, however, prizes address these failures while preserving the features of a desirable market. By specifying the goal rather than the method, prizes lower barriers to entry. This, in turn, encourages a diversity of approaches and 'unusual suspects' to compete, and solutions being found where the path to success is uncertain.

Despite the renewed interest in and enthusiasm for challenge prizes, systematic empirical evidence looking at causal impact and additionality (trying to determine whether or not an innovation outcome would have occurred anyway) is still emerging. This is partly because prizes are highly bespoke interventions; while their ability to be tailored to specific problems is a key advantage for funders, this variation makes standardisation and comparative evaluation difficult. The evidence gap can also be attributed to the general difficulties in assessing impact and additionality, due to the inherent methodological challenges in evaluating prizes. Many of these methodological challenges, however, are equally applicable to other types of innovation support and it is clear that more empirical studies of contemptoary challenge prizes are needed; especially ones that produce quantitative evidence on their effect on innovation – and that make progress towards a more unified framework for evaluating prizes.

By specifying the goal rather than the method, prizes lower barriers to entry.

Nevertheless, the evidence-base on challenge prizes, emergent as it is, still offers important insights and the external literature points to a consensus on a number of key issues – including, notably, widespread agreement that prizes are not a substitute for other innovation policy interventions, but an effective complementary tool when applied under specific conditions. The literature is also clear on prize outcomes being highly conditional on prize implementation; if prizes are poorly designed, managed and awarded, they risk being ineffective or even detrimental.

Selecting the 10 papers

Despite the need for more evidence, the literature on prizes is still wide-ranging, spanning different subjects and multiple decades. For a practitioner or someone new to the area, it can be difficult to know where to start or how best to make sense of what's out there. Hence, these 10 articles were selected to represent some of the most definitive thinking on the subject, and were prioritised on the basis that they collectively:

- **Make the case for why prizes are necessary and where they sit relative to other innovation policy tools.**
- **Draw on important, empirical evidence from modern prizes.**
- **Focus on application, engaging with the how of prize design and implementation, rather than just the why.**
- **Address questions on the effectiveness of prizes and the challenges of assessing prize impact.**

The selection of papers also reflects the practical experience of Challenge Works in having designed and delivered over 100 prizes across the last decade. This extensive practical experience has meant we have collaborated and consulted with a wide network of innovators and problem-experts. Funders and other organisations regularly approach us for advice. This collection, accordingly, reflects part of our continuous learning as an organisation. We hope it can help define the scope and ambition for people and organisations interested in innovation.

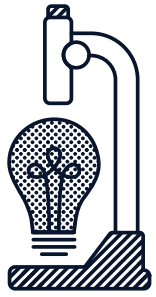
L1 Prize literature: mapping the theory & empirical evidence

This section aims to map, at a high level, the literature on prizes and to summarise the context and current state of knowledge that provides the basis for this report. Fundamentally, the literature on innovation prizes is defined by a dichotomy: significant theoretical justification for the use of prizes, contrasted with limited empirical evidence from actual prizes, particularly from large, contemporary challenges.

On the former, there is a substantial amount of robust discussion covering economic theory, which puts forward challenge prizes as a powerful mechanism for accelerating breakthrough innovation and technological development. The economics literature positions prizes as an alternative or complement to the patent system because they address two specific market failures. First, they mitigate the problem of information asymmetry: unlike grants, where a funder must guess which applicant is most capable at the outset, prizes allow the funder to define a goal and let the most capable innovators self-select to solve it. Second, in theory, they avoid the restricted access caused by patents. While patents incentivise innovation by granting a temporary monopoly (often leading to high prices), prizes can reward the innovator directly, allowing the final solution to be priced cheaply or placed in the public domain for wider societal benefit.

Arguably, these foundational economic arguments and understanding have contributed to the resurgence of interests in the use of prizes over the last two decades, as economists have successfully made clear the inherent limitations and inefficiencies of the patent system as the primary incentive mechanism for innovation. Prizes are well suited to address the fundamental market failures and distortions imposed by patents; making them an attractive alternative policy tool for steering innovation toward socially desirable outcomes. It is important to note, though, that while economic theory seemingly laid the foundation, the resurgence in practice has involved the use of prizes as a complement to patents / IPR, not necessarily as a replacement. New economic models explain this coexistence through patents and prizes working best together because funders are not able to fully predict the features and characteristics of a successful solution – only some of these can easily be measured and contracted on beforehand. By seeing patents and prizes as complementary, however, the cash prize sets the technical goal and the reward for achieving a performance target and the patent links the reward to the solution's success in the market.

Despite the maturity of the economics literature on prizes, the empirical evidence to test, refine and improve this theory has been slower to evolve and the current state of the research presents a major analytical challenge for policymakers and funders. In blunt terms, there is a lack of robust empirical evidence – qualitative and quantitative – on the effectiveness and impact of prizes, and the literature relies heavily on historical case studies to make the case. Whilst case studies of more recent prizes and some small-scale field experiments are starting to emerge in the literature, with the evidence suggesting that prizes can and do spur competitive entry and innovation, these findings are drawn from different and distinct prize forms, limiting the generalisability of the conclusions. In terms of the additionality of prizes – meaning the ability to prove that any innovation outputs would not have occurred without the prize intervention – only a limited number of studies have presented convincing counterfactual analysis to rigorously test the effects of prizes on innovation (though where the evidence does exist, it points to positive impacts on intermediate innovation outcomes).



The lack of robust empirical evidence on the effects of prizes acts as a barrier; limiting the systematic adoption of prizes in the innovation policy toolkit, despite the strong theoretical arguments on their potential. This evidence gap also means that funders and institutions designing prizes lack reliable, evidence-based blueprints, leading to the risk of prizes being ineffective if poorly designed or managed. To partly address these concerns, a useful way to categorise the literature on prizes is through a framework that maps the literature to the essential questions a policy designer or funder typically needs to answer: the why (justification); the what works (impact and mechanisms); and the how to (implementation).

Foundational economics (the why)

Economic theory suggests that markets under-produce innovation because knowledge is a public good. When an innovator shares an idea, competitors can take from this idea and copy it cheaply, which also prevents the original innovator from capturing the full value of their work. To offer a measure of protection, governments grant patents that act as a temporary monopoly. Yet this protection also causes issues; it creates something called "deadweight loss", broadly defined as high prices that restrict public access to the innovation. As a fix to this economic inefficiency, economists proposed the use of cash prizes, where the funder pays the innovator a lump sum and the solution is placed directly into the public domain.

Modern prizes, however, have largely diverged from this theory, as most challenge programmes operate as hybrid models where participants keep their intellectual property. Since perfect information isn't always available to funders and sponsors to calculate the exact reward size, the market is used to determine the commercial value of the innovation. Meanwhile, the cash purse is

seen as a supplement to the initial R&D costs. Because prizes target neglected or overlooked social goods and services, they're seen as working best alongside patents, rather than replacing them entirely.

Recent studies also show that prizes work differently than classic economic models predict. Prizes aren't just a vehicle for a financial transaction. They have other effects that support innovation, like conferring prestige and a signal of quality on competitors, reducing risk for investors, and attracting unusual suspects, who might not normally be engaged through traditional grant funding.

the what works

Empirical evidence and prize mechanisms (the what works)

A body of empirical evidence is starting to emerge and grow on the effects and impact of prizes. One of the central impacts of prizes is that they generate high financial leverage, inducing investment that can significantly exceed the value of the cash purse. For example, in competing for the Ansari X Prize, teams invested over $100 million in pursuit of a $10 million award,, while the Northrop Grumman Lunar Lander Challenge generated a similar ten-to-one investment ratio,. This leverage effect happens because the cash prize isn't always the primary motivator for teams, meaning they spend this money willingly. Instead, they are often more driven by winning a seal of quality that helps them secure future work, investment, and market credibility.

The literature has also looked at the question of additionality – whether prizes generate new innovation or just shift activity from elsewhere. Historical data on this issue suggests that prizes do successfully spur new activity focused on the problem, without reducing innovation in other areas. Programme evaluations further

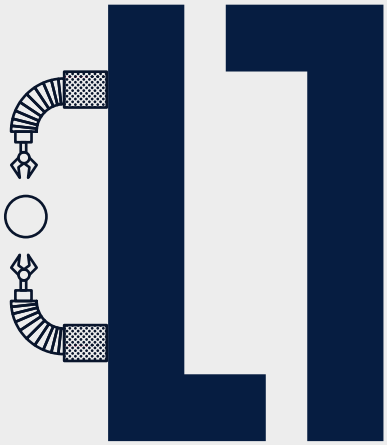
the how to

highlight that prizes often generate their greatest value through spillovers – creating networks, shaping policy, and raising public awareness on an issue – even when the overall technical goal isn't achieved.

Design, governance, and policy integration (the how to)

To run a successful challenge prize competition, organisers need to consider and manage much more than the financial transaction. A prize operates as its own complex social institution and system, where delivery organisations have to govern the process to allow for and manage uncertainties.When the pathway to a new solution remains unknown, organisers have to deal with a number of trade-offs. For example, if rules are too rigid, there isn't the scope to adapt if unexpected discoveries emerge. Yet, if the parameters of the competition are changed too frequently, the legitimacy of the prize is brought into question and participants might leave the contest if they believe the judging criteria are becoming overly subjective. Hence, the literature provides an increasing range of guidance on how design choices can influence outcomes, whether that's for a first-past-the-post competition (awarding a prize to the first to achieve a metric), which prioritise speed, or a best-in-class competition (awarding a prize to the best performer by a deadline), which prioritise quality and novelty, but require more complex judging. To maximise impact, organisers must also think about the infrastructure that supports entrants throughout the process, such as access to testing data, business support, mentoring, and opportunities for networking.

The following section presents ten key papers from across these three overarching areas of the literature.

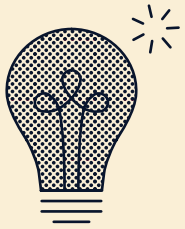


L1 Core foundations: a synthesis of 10 key papers on innovation prizes

For this synthesis, each summary sets out the paper's key findings and presents a short analysis of the key points.

1 Wright, B. D. (1983). The Economics of Invention Incentives: Patents, Prizes, and Research Contracts. *The American Economic Review*, 73(4), 691–707

Key points



- Establishes a framework for comparing patents, prizes, and research contracts / grants in support of innovation.
- Theoretically, prizes are superior to patents in that they can allow solutions to be placed in the public domain, meaning that access isn't unnecessarily restricted.
- Ultimately, the choice on which funding tool is best is context specific and especially driven by how much information the funder has at the outset about the cost and value of the innovation, relative to what the innovator knows.

Intro

Introduction

How can governments and funders make the most informed choice on how to stimulate innovation – whether that be through the application of intellectual property rights (patents), the use of large cash awards (prizes), or direct public funding (contracts or grants)? Wright sought to answer this important question by looking at the specific conditions for when each of these three funding mechanisms might be the best choice for maximising social value. The paper presents a model that takes into account a critical element overlooked by earlier studies – the difference in information and understanding held by the funder versus the innovator.

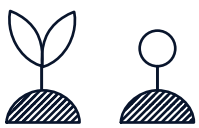
the why

Main findings and conclusions

The core conclusion from Wright's paper is that any one of the mechanisms could be the best choice for innovation, depending on how well they deal with and mitigate three economic problems: lack of knowledge sharing, inefficiencies created by monopolies, and over-investment by participants in competitive situations. To briefly explain each of these, a lack of knowledge sharing occurs because new knowledge often acts as a public good. This means that innovators can find it difficult to prevent competitors from freely copying their work. Competitors can then quickly replicate the idea, but without having to cover the same R&D costs. To add to the difficulty, governments and funders often have less detailed understanding of the necessary R&D costs or market demands than innovators have themselves. This lack of shared knowledge (information asymmetry) leads to the core problem of innovators not investing their time and money, due to knowing that they can't capture the full financial value of their discoveries.

Prizes and patents are both held as better options than direct contracts or grants when R&D costs are uncertain.

Governments issue patents as a way to grant a temporary monopoly over a new technology, protecting innovators from having their ideas copied cheaply by rivals. Whilst this then allows the innovator to charge a price that enables them to recoup their investment costs and make a profit, it also provides scope to charge artificially high prices that prices out people who could genuinely benefit from the innovation. Economists refer to this as 'deadweight loss' – the lost social benefit that follows when a discovery is prevented from reaching the widest possible market.

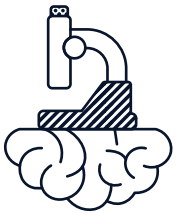


From an economic perspective, the problem of competitive over-investment occurs when you have multiple, competing teams racing to win or claim a significant financial reward. The result is a risk of teams

duplicating each other's work and keeping their intermediate findings secret. This self-serving dynamic creates a 'common pool problem', where the collective resources spent by all the participants can significantly outweigh the value of the final / winning solution. Economic theory suggests that it would be better to have competing innovators coordinate their efforts to solve the challenge more efficiently, and not have capital and human talent taken up when it could've been repurposed to solve other pressing problems.

Wright argues that the optimal choice depends on specific conditions related to information about the problem and market characteristics and structure. In the trade-off between prizes and patents, the paper finds that prizes are superior to patents if the funder is well-informed about the social value of the innovation and the R&D costs required to develop it. In this ideal scenario, the prize purse should be the equal value of the social value of the innovation. Patents are better for providing incentives that are more clearly linked to actual market demand. The ability to link commercial returns to market signals make patents the preferable option when governments and funders have incomplete information on the costs and benefits of the desired innovation.

Wright's model proposes that prizes are the optimal choice for R&D initiatives when the challenge is difficult – or the sweet spot in between a routine task and a more speculative moonshot – and where the supply of R&D capacity or capability is relatively scarce or unknown. Prizes and patents are both held as better options than direct contracts or grants when R&D costs are uncertain. Where innovation projects have a high chance of success because the work is incremental and predictable, then funders should use a contract or grant to pay someone to do the work.

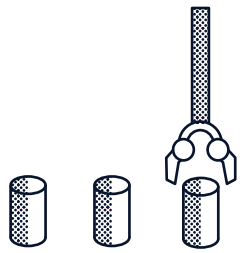


the why

Analysis – why Wright's model still matters?

Wright's paper remains a key theoretical foundation for contemporary innovation policy. The idea that the choice between the different mechanisms is primarily guided by how much information the funder and the innovator each have is still a useful heuristic to consider and apply. When funders have perfect information, prizes should be the preferred choice as, in theory, they overcome the problem of monopoly pricing. In situations where funders have less information, patents are desirable because they defer investment decisions to the better informed parties – the innovators themselves. Consequently, the broad parameters for when prizes are best are when the social value of the solution is high, when the funder is unsure about which path the solution could take, and when the pool of innovators is relatively scarce or widely spread. Although Wright argued that funders often lack the necessary information and detail to set effective prizes, contemporary prizes seek to overcome this information asymmetry through an intensive design process, where in-depth research with problem-holders, domain experts and end-users can help to accurately set the financial incentives and related support.

The framework developed by Wright identifies a range of key variables that need to be considered in the prize design phase. Wright viewed patents and prizes as substitutes. But the difficulty in estimating the social value of an innovation has led to newer models – and the now relatively established practice of allowing innovators to retain their IP. This hybrid model of prize plus patent rights is arguably justified as a way to correct for deficiencies in both mechanisms when used as standalone interventions, and reinforces the point that valuing an innovation ex ante is difficult. Wright emphasised the importance of setting the reward based on the social value of the innovation. A prize set too low



risks not attracting participants and enough effort, while a prize purse that is too high can result in wasteful duplication. This insight is still relevant to policy questions about how to effectively size prize competitions. Finally, Wright's model assumes that the prize incentive is entirely determined by the financial value of the reward. Subsequent empirical research, however, suggests that participants respond to a wider range of incentives, such as prestige, publicity and reputation gains. Hence, while Wright's model was critical to defining the boundaries of different financial incentives, in practice, actual price effectiveness is often the result of non-financial factors.

Although Wright argued that funders often lack the necessary information and detail to set effective prizes, contemporary prizes seek to overcome this information asymmetry through an intensive design process...

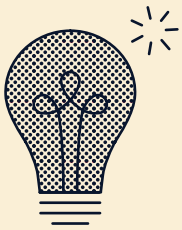
the why

2

Kremer, M. (1998). *Patent Buyouts: A Mechanism for Encouraging Innovation.* The Quarterly Journal of Economics, 113(4), pp. 1137–1167.

Key points

- Patents work to encourage innovation but lead to monopoly pricing, which is not good for society. Meanwhile, pure prizes can be ineffective because the funder doesn't necessarily have all the information to set the correct reward amount beforehand.
- A patent buyout mechanism, a form of prize structure, can provide a solution to this problem. It uses a competitive auction to accurately determine a solution's market value, after it has been developed.
- This type of mechanism resolves a core flaw in the patent system, while simultaneously addressing a key flaw in pure prizes; a lack of information. It is the foundation of pull mechanisms like advance market commitments (AMCs).



Intro

Introduction

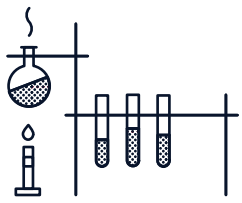
Economic policies are required to encourage and support innovation, as new ideas often take the form of public goods; once created, these ideas can be easily copied, which discourages private investment in R&D. The patent system is seen as the primary answer to this problem, allowing innovators a temporary monopoly to recover their investment costs. As Wright (1983) established, however, this lets innovators charge higher prices than necessary, which restricts market access and causes inefficiencies. Prizes can resolve this inefficiency by placing the innovation immediately in the public domain. But funders are frequently in a position of not knowing the true cost or

social value of an innovation beforehand, making it equally difficult to set the appropriate prize amount in advance. Kremer's solution to these shortcomings of both patents and prizes was to introduce the concept of a patent buyout. This is a specific type of inducement prize mechanism that circumvents the issue of monopoly pricing, at the same time as using the market to accurately set the prize size.

Main findings and conclusions

Kremer argues that a structured patent buyout mechanism can overcome the constraints of information asymmetry to make prizes a more feasible option in a range of scenarios. Kremer's concept relies on the use of an auction mechanism to work out the private value of a patent to a group of informed competitors. A government or funder can then use this market-informed valuation to calculate the level of compensation to offer to the innovator; typically, this compensation amounts to the patent's estimated private value multiplied by a markup. The additional markup is intended to cover the difference between the innovator's private return and the total social value of the solution, thereby ensuring sufficient incentives for novel, high-value R&D. If the innovator decides to accept the buyout, the innovation is placed immediately in the public domain, which avoids all deadweight loss. Additionally, to ensure that competing firms bid honestly in the auction, a random mechanism is included so that in a small number of cases, the patent is actually sold to the highest bidder, instead of being bought out by the government.

Analysis – incentives, public goods and future innovation



Kremer's paper provides a framework for how to fund socially important, high-high impact innovation. Within

the why

Patents can act as a barrier to cumulative innovation because either licensing arrangements or high transaction costs block future research.

the literature, it is considered as one of the most effective ways to address some of the conflicts inherent in both prizes and patents. The patent buyout works well because the auction acts as a highly efficient way to draw out information and market preferences. Otherwise, if a government or funder attempts to set a prize amount using its own estimates, there is a risk it ends up paying too little (disincentivising R&D) or too much (resulting in wasted efforts). Getting industry rivals to bid on the patent rights, with their superior knowledge of development costs and market value, provides the funder with a clear market signal. This, in turn, allows the funder to determine the appropriate level of reward after the innovation has been successfully developed.

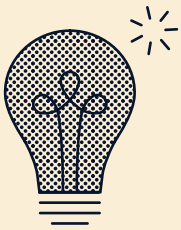
In many problem areas, innovation is cumulative. New discoveries build directly on previous ones. Patents can act as a barrier to cumulative innovation because either licensing arrangements or high transaction costs block future research. By removing the patent, the buyout mechanism supports and encourages follow-on innovation and aims to maximise social gain.

Kremer's patent buyout concept is key to understanding the effective use of innovation inducement prizes. Kremer's thinking helped to popularise the idea that patents and prizes don't have to be mutually exclusive substitutes. In practice, they can be combined to leverage the strengths of each mechanism. The patent buyout also provided the foundation for AMCs; a closely related mechanism where the financial reward is based on a guarantee to buy a set quantity of a future product. AMCs use market signals in a similar way to ensure an innovation is both technically feasible and socially valuable. This helps to avoid the risk of rewarding a technology that consumers do not want. Since there is uncertainty about the cost-benefit of prizes, which acts as a barrier to their use in policy, Kremer has argued for a trial of patent buyouts to provide the evidence to decide on wider-scale adoption.

3 Shavell, S., & Van Ypersele, T. (2001). Rewards Versus Intellectual Property Rights. *The Journal of Law and Economics*, 44(2), 525–547

Key points

- Compares the incentives for innovation provided by intellectual property rights (IPR) with reward mechanisms like prizes.
- Patents are seen as flawed because they lead to high prices that limits public access to the solution, resulting in the loss of social benefit and economic inefficiency.
- Cash prizes fix this issue because, in theory, they place the innovation immediately in the public domain, making it more widely available. Yet, governments and funders face an information problem; they often lack the necessary information to accurately set the cash reward.
- Patents do not necessarily have a fundamental advantage over prize reward mechanisms. The best approach is to allow the innovator to choose between either a cash reward or keeping the patent.



Intro

Introduction

Shavell and Van Ypersele address the question of how governments can best encourage the development of new technology and scientific breakthroughs. They compare the IPR system against a cash reward system, where the government pays innovators directly and immediately places the invention in the public domain. The paper looks to determine which approach maximises social welfare, accounting for the risk of R&D investment and the difficulty governments face in assessing the true market value of a solution.

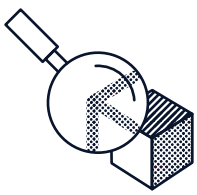
the why

Main findings and conclusions

Shavell and Van Ypersele conclude that patents don't hold a fundamental social advantage over reward systems like challenge prizes. The comparison made by the authors is based on two main opposing elements. Firstly, reward mechanisms are superior because the issues caused by monopoly pricing are avoided when the innovation is immediately placed in the public domain. This benefit is particularly valuable in areas like pharmaceuticals or software, where production costs are typically low, but when patent prices can be substantial. Secondly, the patent system links an innovator's profits to the actual demand for the product. This provides innovators with superior information and the incentive to pursue projects that are most valued by the market. With a pure reward mechanism, this link is absent and so the incentive to invest is set by the government's pre-determined reward, which may be insufficient if the government lacks the information about true market demand.

The paper proposes that an optional reward system is the most effective approach. Under this system, the innovator makes the choice between receiving a patent or a prize reward. This hybrid option is seen as superior to a mandatory patent system because it eliminates deadweight loss when the innovator chooses the prize reward, improving expected social welfare and benefits.

Analysis – prizes and policy design



This research is significant because it challenges the assumption that the patent system is the best mechanism for innovation, and infers that hybrid models can significantly increase social welfare and public benefit. It reinforces the idea that prizes offer a legitimate, and often superior, alternative to patents.

the why

The challenge governments face is a lack of information. If the social value of an innovation is greater than the predetermined reward, then this insufficient incentive can lead to underinvestment. The model confirms the long-held argument that the major advantage of patents is their ability to leverage private information from innovators about market demand and potential profits. Innovators use this information to screen out low-value R&D projects, which is a crucial task that governments struggle to replicate.

For policymakers, a key consideration is the superiority of the optional reward system. This system allows for prize amounts to be set moderately. Innovators with high-value solutions, where the market returns likely far exceed the government's moderate reward, will invariably choose the patent. For solutions with less commercial value but high social value, or where monopoly pricing is inefficient, innovators can choose the reward. This selection process means that the incentives for innovation are improved, relative to a pure patent system, which consistently provides inadequate incentives because private profits are always less than the overall social value.

Although Shavell and Van Ypersele originally modeled patents and prizes as substitutes, with prizes requiring innovations to be put in the public domain, their conclusion strongly supports a hybrid model that allows innovators to retain IP rights while still receiving a cash reward. This hybrid structure addresses the information and incentive gaps identified in the literature. It also provides the justification for using prizes specifically in fields where the social cost of monopoly pricing is excessively high, such as for essential public goods (e.g., pharmaceuticals or climate technologies).

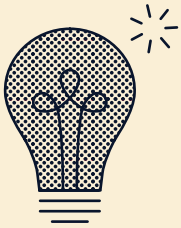
the why

4

Galasso, A., Mitchell, M., & Virag, G. (2018). A theory of grand innovation prizes. *Research Policy*, 47(2), 343–362

Key points

- Traditional economics sees patents and prizes as substitutes. But real-world, large-scale competitions, or grand innovation prizes (GIPs), typically allow innovators to keep both their patent rights and receive a cash reward.
- It explains why this hybrid approach is used. Fundamentally, the difficulty in specifying all technical details of a breakthrough solution in advance means that patents and cash prize rewards are complements, not substitutes.
- This hybrid GIP structure often generates more innovation and social welfare than relying on either pure patents or pure prizes on their own.
- The GIP model corrects the tendency of patents to focus on speed of discovery, over the long-term quality and societal impact of an innovation.



Intro

Introduction

Economic theory proposes that if a government or funding institution offers a prize for an innovation, that solution should be placed immediately into the public domain to prevent the monopoly pricing and inefficiency that comes with patents. Accordingly, patents and prizes should be used as mutually exclusive alternatives. In reality, however, sponsors of large-scale GIPs often allow winners to retain patent ownership. The paper looks at why this hybrid model is used, and how it can be justified.

the why

It explains this apparent paradox by assuming that innovation efforts are multi-dimensional. Some parts of the solution can be clearly defined and measured beforehand, but others – such as consumer appeal, ease of manufacturing, or long-term systemic impact – are either hard to measure or not easily written into the prize rules.

Main findings and conclusions

The GIP system generates greater social benefit and more innovation effort compared to either a patent or a prize in isolation. It does this because it eliminates two distinct forms of research underinvestment. With patents, innovators underinvest in clear, measurable targets because they only capture a fraction of the solution's total social value through their monopoly profits. Equally, in the prize system, innovators drastically underinvest in the unmeasurable dimensions (e.g., quality, usability) because they only need to hit the measurable target to win the cash reward. Hence, it can be rational for innovators to disregard anything else. The hybrid GIP corrects both of these issues. The cash reward ensures the measurable targets are met, while retaining the patent incentivises the innovator to maximise the overall value of the entire solution to maximise their profits.

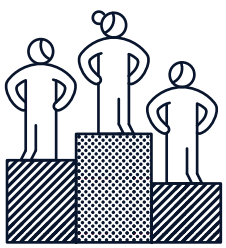
Analysis – practical application of the hybrid model

This model provides the economic justification for why modern large-scale challenge prizes are designed the way they are. The complexity of breakthrough innovation, especially for grand challenges where the solution path is largely unknown, makes it near impossible to write a complete set or prize rules and criteria specifying every desired feature of the final technology.

the why

Prizes, therefore, are effective pull mechanisms for ensuring that innovators achieve the specific targets set by the funder or sponsor. This is especially useful for problems susceptible to market failure (e.g., public health) where the patent alone would likely fail to provide an adequate incentive. Patents are a good way to manage quality. By allowing the innovator to retain IP rights, the prize ensures the inventor is rewarded by the market for all the hard-to-measure, value-adding efforts necessary to make the product viable, desirable, and scalable. The patent acts as an additional incentive for the innovator to cover R&D costs that go beyond the prize purse.

The model suggests GIPs are most effective when the problem is complex, multi-dimensional, and can't be perfectly described or specified in the initial rules. Prizes should be used on their own when the solution can be precisely described and the problem is largely one dimensional. This fits with observed differences between GIPs and smaller-scale contests for well-defined problems. The hybrid approach allows the funder to provide larger innovation incentives by using the strengths of both mechanisms. This maximises the social benefit generated by the competition.



the why

Other notable papers

Arrow, K. J. (1962). Economic Welfare and the Allocation of Resources for Invention. In R. R. Nelson (Ed.), The Rate and Direction of Inventive Activity: Economic and Social Factors (pp. 609–626). Princeton, NJ: Princeton University Press.

This seminal paper establishes why free markets often fail to produce enough innovation. Arrow argues that knowledge is a public good that is cheap to copy once created, which limits innovators from making a profit. Since innovators aren't able to capture the full value of their work, they invest less than is beneficial for society. Arrow calls for government intervention to fix this underinvestment. He argues that direct government financing is often superior because it avoids monopoly pricing that patents create, allowing information to be used freely by everyone.

Chari, V. V., Golosov, M., & Tsyvinski, A. (2012). Prizes and patents. Using market signals to provide incentives for innovations. Journal of Economic Theory, 147(2), 781–801.

This paper looks at whether prizes can replace patents by using market sales data to calculate the reward size. If market signals, like sales figures, are accurate, prizes are superior to patents because they avoid the problem of monopoly pricing. However, if innovators can manipulate these signals, through practices such as buying their own products or bribing competitors to inflate sales figures, prizes become ineffective. Patents are necessary when the risk of manipulation is high, but prizes are preferable when the government can reliably verify market performance.

the why

Clancy, M. S., & Moschini, G. C. (2013). Incentives for innovation. Patents, prizes, and research contracts. Applied Economic Perspectives and Policy, 35(2), 206–241.

Provides a comprehensive and accessible review of patents, prizes, and grants. It summarises the consensus from the literature and sets out the questions policymakers need to consider when weighing up different incentive mechanisms.

Kremer, M., & Williams, H. (2010). Incentivizing Innovation: Adding to the Tool Kit. In J. Lerner & S. Stern (Eds.), Innovation Policy and the Economy, Volume 10 (pp. 1–17). Chicago: University of Chicago Press.

Kremer and Williams state that policymakers should use prizes and AMCs as voluntary supplements to patents. Replacing patents entirely creates political risk and uncertainty for investors. Instead, pull mechanisms should be tested, where innovators can choose to give up their patent in exchange for a prize or a guaranteed purchase contract. This allows governments to target specific needs, such as vaccines for neglected diseases, while maintaining the incentives of the existing IP system. Prize payouts should be based on a market test, where possible, so that technologies are funded that deliver scalable social value.

Nalebuff, B. J., & Stiglitz, J. E. (1983). Prizes and Incentives: Towards a General Theory of Compensation and Competition. The Bell Journal of Economics, 14(1), 21–43.

Develops the theory of tournaments, where compensation is based on relative performance, rather than absolute output. Competitive prize structures are effective when it is difficult to measure a participant's effort directly or when environmental or external factors affect everyone's performance. By rewarding the best ranking innovator, funders can make allowances for common shocks (like bad weather in agriculture) that

affect all contestants. However, designing the prize structure incorrectly can influence how much risk contestants take, potentially leading to either too little or too much risk-taking behavior.

Taylor, C. R. (1995). Digging for Golden Carrots: An Analysis of Research Tournaments. The American Economic Review, 85(4), 872–890

Taylor analyses how to design research tournaments when entrants have identical abilities. He challenges the assumption that 'the more the merrier; applies to innovation contests. His model shows that allowing free entry leads to a common pool problem, where too many firms duplicate effort, wasting resources. To maximise the value of the tournament, funders should restrict entry, either by charging an entry fee or by short-listing a specific number of qualified participants. This ensures that the research effort is efficient and that the prize purse remains a strong enough incentive for those who do compete.

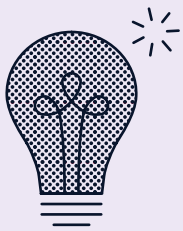
the what works

Empirical Evidence and Mechanisms – The What Works

5 Kay, L. (2011). The Effect of Inducement Prizes on Innovation: Evidence from the Ansari XPrize and the Northrop Grumman Lunar Lander Challenge. *R&D Management*, 41(4), 360–377

Key points

- Prize participants are motivated by a broader range of incentives than just the cash reward. Non-financial incentives like reputation, learning, and prestige often carry more weight for new and unconventional entrants.
- Cash prizes successfully induce R&D investment that can far exceed the prize purse. The $10 million Ansari X Prize spurred over $100 million in R&D investment.
- Unconventional teams bring new ideas and knowledge (e.g., applying software engineering approaches to aerospace R&D), which is the primary source of novel research and high-value approaches in prize competitions.
- Prizes can accelerate ongoing R&D or prompt entirely new R&D activity, resulting in innovations that might not have occurred otherwise.



Intro

Introduction

Kay's research directly addresses the evidence gap to demonstrate how innovation inducement prizes work and, critically, whether they actually lead to innovations that otherwise wouldn't have been developed. This study investigates the motivation of prize entrants, the nature of their R&D activities, and the overall effect of prizes on innovation, using two high-profile space sector competitions as case studies:

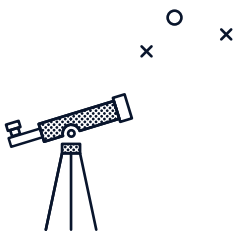
The Ansari X Prize: A $10 million prize for the first private reusable manned spacecraft to reach suborbital space twice in two weeks (1996–2004). This was designed to break critical technological barriers and stimulate a market for private spaceflight.

The Northrop Grumman Lunar Lander Challenge: A multi-year, $2 million competition (2006–2009) sponsored by NASA, focused on building reusable rocket-powered vertical take-off and landing (VTOL) vehicles. This prize aimed to accelerate the commercial development of technology aligned with NASA's exploration goals.

Main findings and conclusions

Prize mechanisms work largely by creating a broad range of incentives that extend beyond the cash prize itself. For many participants, these diverse motivations, such as publicity, credibility, reputation, and self-fulfilment, often outweigh the financial incentives. The incentives created by a competition, especially the non-financial benefits, have a particularly significant effect on unconventional entrants – individuals or organisations not traditionally involved in the prize technology/field. The potential market value of the prize technology also motivates entrants.

Both prizes studied successfully leveraged large amounts of R&D investment that exceeded the prize money. The $2 million NGLLC crowded in an estimated $20 million total investment, whilst the $10 million Ansari X Prize leveraged over $100 million in R&D activities.The prizes were found to have induced innovative activity beyond what would have occurred anyway. The AXP accelerated ongoing R&D, while the NGLLC triggered new R&D activity in a narrowly defined technology sector that previously had no active developments.

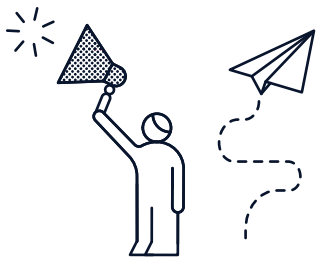


Analysis – redefining prize incentives and R&D

Kay's research provides evidence on how prizes provide a set of incentives that leverage external investment and attract diverse talent. For many teams, the financial reward was secondary. Instead, the competition served as an important market signal and a platform to build credibility. The prize money, though, is essential for generating global attention and publicity, which then created the non-monetary incentives (like recognition and reputation) that motivated competitors. The prize's ability to generate high levels of investment exceeding the prize purse suggests that entrants are responding rationally to a broader incentive structure than previously assumed by purely economic models.

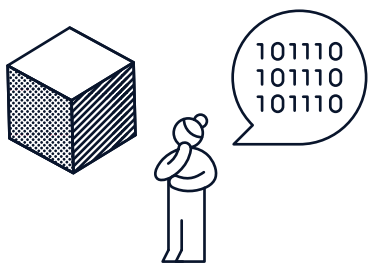
Attracting unconventional teams is a major benefit of prizes. The AXP attracted 26 private teams, and 18 of them were unconventional. In the NGLLC, the majority of entrants were small, independent R&D groups. These teams, often made up of individuals with backgrounds in unrelated fields (like software development in the NGLLC), brought novel R&D approaches that differed from traditional industry practices. This flow of new ideas into a mature sector enabled the development of simpler, low-cost technological solutions.

The comparison between the two cases provides important design lessons. The AXP had broad, open-ended rules. This was critical for introducing novel R&D approaches and encouraging teams to focus R&D effort on developing breakthrough technology. Kay concluded that open-ended rules and significant technology gaps increase the likelihood that prizes will induce innovation. The NGLLC used a narrowly defined target and detailed technical specifications reflecting particular needs. This structure was effective at accelerating development in a specific, well-understood technology area.



The ability to retain IP is key for fundraising and future commercial work. Because prizes often provide no up-front R&D funding, innovators rely heavily on private investors. Allowing them to keep their patents gives investors the assurance of future returns, creating a path for a sustainable business (e.g., the AXP winner secured a $250 million contract with Virgin Galactic shortly after the win). Policymakers must account for the fact that prize success is conditional on links to a future viable, commercial market. A prize is a validation platform that facilitates the crucial post-prize activity needed to develop and scale the innovation.

The prize money, though, is essential for generating global attention and publicity, which then created the non-monetary incentives (like recognition and reputation) that motivated competitors.

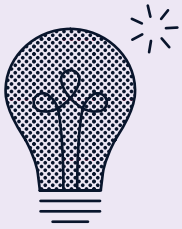


the what works

6 Boudreau, K. J., Lacetera, N., & Lakhani, K. R. (2011). Incentives and Problem Uncertainty in Innovation Contests: An Empirical Analysis. *Management Science*, 57(5), 843–863.

Key points

- Economic theory suggests limiting the number of participants in a prize competition to maintain strong incentives. This research tested whether this is a better approach than widespread entry, which real-world contests typically seek.
- Increasing the number of participants generates two opposing effects at the same time: a negative incentive effect, where participants apply less effort because their chance of winning is lower; and a positive parallel path effect, where more independent efforts increase the chance of finding the single best/high-value, breakthrough solution.
- For well-understood problems, the negative incentive effect is dominant, meaning that adding innovators reduces overall performance.
- For high-uncertainty problems requiring novel, complex solutions, the positive parallel path effect dominates, meaning that adding innovators increases overall contest performance and the likelihood of finding an extreme-value solution.



Intro

Introduction

As the use of challenge prizes has grown again, a critical question for funders and delivery organisations is how large should the prize competition be?

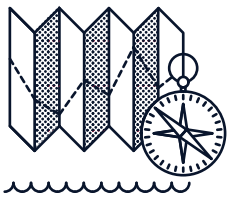
Traditional economic models suggest that as the number of competitors increases, the likelihood of any single competitor winning declines. This negates the incentive for the individual to exert maximum effort and invest resources, and risks seeing a drop in the overall quality of solutions. Yet, in practice, many funders and prize sponsors encourage wide, open participation. Boudreau, Lacetera, and Lakhani sought to test this trade-off using a large dataset from online software development contests. Their research examines the negative effect on individual motivation versus the positive effect of increasing the pool of innovators to find a breakthrough solution.

Main findings and conclusions

Based on an analysis of 9,661 software contests, the researchers identified two co-existing and opposing forces that come into play when the number of competitors increases:

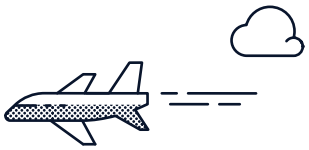
Negative incentive effect: as the number of competitors increases, the average performance across all participants tends to decrease. This is consistent with economic theory – individual participants are less likely to win, so they reduce their effort and investment.

Positive parallel path effect: adding competitors significantly increases the likelihood of finding the single, highest-scoring, extreme-value solution. This effect stems from the broadcast search model, where a greater number of independent attempts increases the chance that someone finds the optimal path.



The effectiveness of open entry depends on the level of uncertainty for the problem being solved. When problems are highly complex and require multi-domain

knowledge (i.e. high uncertainty), the benefits of many parallel searches outweigh the drop-off in individual effort. In these cases, increasing the number of competitors increases overall competition performance and the quality of the winning solution. When problems are simpler or draw from a single knowledge domain (i.e. low uncertainty), the negative incentive effect is prevalent, so adding competitors results in inferior outcomes.



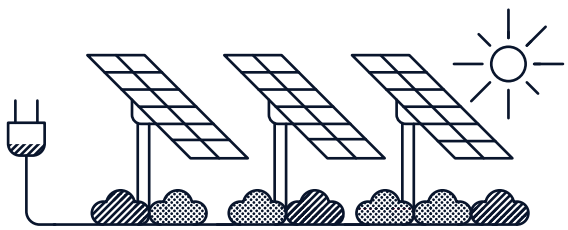
Analysis – designing prize competitions for uncertainty

Prize stakeholders and policymakers need to understand how problem uncertainty determines which of these two effects influences the final outcome. The nature of the problem is the variable that affects the success of open innovation competitions. The research provides prize managers and funders with a clear design mandate – the number of participating innovators should be calibrated to the nature of the challenge. High uncertainty is attached to problems requiring true breakthroughs. In these scenarios, prize organisers should maximise the number of competitors to benefit from the parallel path effect. This increases the odds of discovering the best possible solution. For problems where the solution path is largely known (low uncertainty), limiting the number of contestants is likely to lead to higher individual effort and more efficient allocation of resources.

Since increasing competition reduces individual incentives and causes many participants to lose, prize managers should provide ancillary benefits of participation (non-financial incentives and support) to attract and retain solvers who are unlikely to win. These benefits could include learning opportunities, mentoring, access to data or testing facilities, and networking / peer support. This aligns with other research showing that non-financial incentives are often highly motivating for prize participants.

Defining and understanding the uncertainty of the challenge problem is a crucial design consideration. Uncertainty can be conceptualised and measured by observing whether the problem draws on single or multiple knowledge domains. This provides prize organisers and delivery organisations with a practical way to assess a challenge before implementation. If the specific technological solution cannot be fully defined or specified ex ante, then a prize mechanism is an appropriate tool to seek a breakthrough innovation.

Since increasing competition reduces individual incentives and causes many participants to lose, prize managers should provide ancillary benefits of participation (non-financial incentives and support) to attract and retain solvers who are unlikely to win.



the what works

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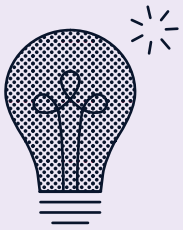
Brunt, L., Lerner, J., & Nicholas, T. (2012). Inducement Prizes and Innovation. *The Journal of Industrial Economics*, 60(4), 657–696.

Key points

- Establishes a causal relationship between inducement prizes on innovation output, measured through patents.
- Impact on innovation was driven primarily by non-monetary awards, such as medals and prestige. These were found to be more important in increasing patents than monetary prizes.
- Prizes work effectively by providing a 'seal of quality' for participants. The prestige conferred by an award helped innovators to advertise and promote their products to potential buyers.
- The observed impact on innovation could not be explained by existing activity being redirected, implying that prizes successfully raised the overall output of innovation.



Intro

Introduction

Theoretical arguments in support of challenge prizes have been well developed, positioning them as an effective alternative or complement to the patent system. However, the field has lacked robust empirical evidence demonstrating their effectiveness, and proving that they actually spur new innovation rather than simply re-directing existing research efforts.

Brunt, Lerner and Nicholas addressed this evidence gap by analysing a dataset of awards for technological development offered by the Royal Agricultural Society of England between 1839 and 1939. By matching 15,032

competing inventions to records of British patents, they sought to determine whether inducement prizes can successfully accelerate technological development.

Main findings and conclusions

The study used econometric analysis to correlate RASE awards with patterns in competitive entries and patent records, with patents acting as a proxy for innovation. Prizes were found to have large positive effects on competitive entry to the contests. Doubling the number of awards offered induced a 33 per cent increase in entrants. The research also found a positive effect on patents. This impact on innovation was primarily driven by the prestigious, non-monetary prizes (medals), which were found to be more important than financial awards in increasing patent numbers and quality.

Checks were carried out to ensure the boost in innovation wasn't simply the result of innovators shifting their attention from other areas. A redirection of existing activity didn't provide a plausible explanation for the increase in innovation, confirming that prizes successfully generated aggregate innovative output. This effect was still observed even when focusing only on prize categories determined by a strict rotation scheme, which mitigated the risk of prizes only targeting 'hot' technology sectors.

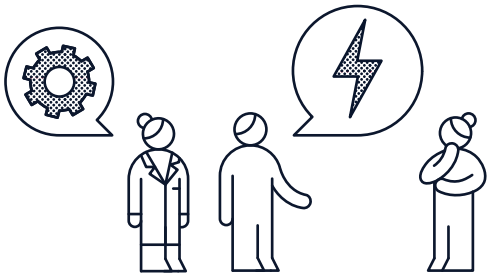
Analysis – the value of non-monetary incentives

The study provides robust quantitative evidence that prizes do work to induce innovation, whilst demonstrating that non-financial incentives are a powerful tool for achieving this outcome. This last insight is significant for effective prize design. The reason medal awards were more effective than cash rewards is that the awards provided a "seal of quality" for innovators. This allowed

inventors to advertise their success and talent to potential investors, helping them overcome market uncertainty and to support commercial pathways post-prize. Prize organisers, consequently, need to consider incentives beyond finance and intellectual property rights and to account for other key incentives like media attention and reputation.

The study's methods provide evidence of a causal effect and address the question of additionality. The use of historical data and econometric approach provide helpful markets for how to advance and develop prize evaluation, particularly in enabling a counterfactual analysis. The spikes observed in patenting activity occurring in the year of the RASE show also suggest an immediate relationship between the awards and innovation activity.

The additionality observed in the study suggests that innovation prizes work best as a complementary tool within the wider innovation ecosystem. Prizes support the wider diffusion of technical information through public events. The prestige and credibility that the prize generates boosts interest in and demand for innovators' solutions, increasing the financial returns that would've been earned just through the patent system.

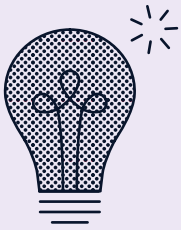


8

Graff Zivin, J. & Lyons, E. (2021). The Effects of Prize Structures on Innovative Performance. AEA Papers and Proceedings, 111, pp. 577–581.

Key points

- While economic theory presents various arguments for how best to incentivise innovation, there is a lack of empirical evidence testing how prize funding structures affect innovator performance.
- A winner-takes-all prize structure generates more novel, breakthrough innovation than a structure with the identical amount of prize money shared across multiple winners.
- Prize funding structure affects the risk-taking behaviour required to produce highly novel, impactful solutions, but doesn't change the overall quantity of submissions or the general average quality.
- Teams are highly responsive to winner-takes-all incentives, producing substantially more novel solutions than individuals do when competing.



Intro

Introduction

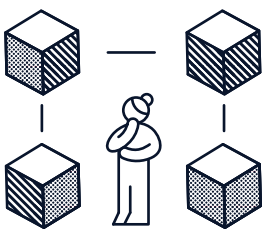
As organisations increasingly use innovation prizes to address difficult challenges, funders and organisers face an important design choice: how to optimally structure the prize purse. Graff Zivin and Lyons investigate whether a winner-takes-all structure helps to create the right mix of effort and risk-taking, or if incentives that reward a greater number of innovators are more preferable. A software innovation contest, hosted byThermo Fisher Scientific, was used to run a randomised controlled trial. Participants had to design solutions to help share medical equipment among small healthcare providers in Mexico. Participants were randomised into two different

funding structures, each with the same total financial payout of $15,000. In the winner-takes-all arm, a single $15,000 prize was awarded to the highest-ranked submission, providing high-powered incentives but no fallback in the event of failing to win. In the multiple-prize arm, the $15,000 was split across the ten best proposals, providing participants with a safety net in case their proposals were not best-in-class.

Main findings and conclusions

The experiment demonstrated that prize structure significantly impacts the quality and novelty of innovative output, without affecting the overall amount of effort. In both funding structures, approximately a third of participants submitted a proposal for evaluation. The overall quality scores across five distinct judging criteria were statistically similar. Submissions made under the winner-takes-all competition, however, were judged to be significantly more novel, relative to existing products on the market than those in the multiple-prize competition.

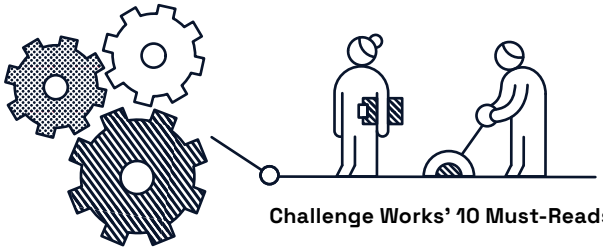
The researchers also found that the way people are compensated or rewarded has a much larger impact on creativity for teams, than for individual innovators. Teams submitted projects that were approximately 25 percent more novel under the single-prize structure than under the multiple-prize structure. Conversely, individual participants submitted projects of similar novelty irrespective of which prize structure they were allocated to. A participant's baseline risk appetite was shown to be a key factor in their success. Participants who were more willing to take on risk produced significantly more novel innovations under the single-prize structure. Participants less inclined to take risks were less capable of pursuing unproven, non-standard problem-solving strategies, meaning they did not produce more novel work even when the skewed compensation scheme incentivised them to do so.



Analysis – high-powered incentives and team dynamics

This study provides causal, actionable evidence on prize structure for funders and policymakers. Providing a sizable reward solely for the top performer encourages the risk-taking required to explore unproven, radical approaches. Since the novelty required for breakthrough innovation provides a higher likelihood of spectacular success and complete failure, spreading prize money across multiple winners inadvertently encourages competitors to submit safer, incremental ideas.

The research highlights the crucial role of team dynamics in challenge prizes. The increase in novelty under the winner-takes-all structure was driven almost entirely by teams. Prize organisers aiming for radical breakthroughs should actively encourage teams to combine and collaborate, where feasible. Teams with diversified skill-sets are better placed to address the technical demands of high-risk competitive environments. The research suggests that if a funder wants to induce truly novel ideas, they must encourage innovators to take on risk, which in the context of this study, was achieved by concentrating the financial reward at the top.



the what works

Honourable mentions

Davis, L., & Davis, J. (2004). How Effective Are Prizes as Incentives To Innovation? Evidence from Three 20th Century Contests. Paper for the DRUID Summer Conference on Industrial Dynamics, Innovation and Development, Denmark.

The study examines three major prize competitions: motorised flight, human-powered flight, and energy-efficient refrigerators. Prizes were found to be effective at signaling market needs and generating publicity, often providing value to entrants greater than the cash prize. However, winning a prize does not guarantee commercial success, particularly if factors like the regulatory pathway are problematic. Prizes are considered to work best when they allow for open-ended solutions, but additional consideration is required on how to support the market adoption of a winning technology post-prize.

Jin, C., Ma, Y., & Uzzi, B. (2021). Scientific prizes and the extraordinary growth of scientific topics. Nature Communications, 12(1), 5619.

The study presents an analysis of over 400 scientific awards between 1970 and 2007, and demonstrates that prizes accelerate the growth of scientific topics. In the decade following an award, topics associated with a prize programme experienced a significant increase in productivity, receiving 40% more publications and 33% more citations than matched non-prize topics. It suggests that prizes function as a powerful signal that can direct scientific attention and resources toward targeted areas. They can be effective tools for, shaping the future trajectory of scientific fields and attracting new entrants to a problem area.

Lakhani, K.R., Jeppesen, L.B., Lohse, P.A., & Panetta, J.A. (2011). The Value of Openness in Scientific Problem Solving.

The study analysed 166 scientific problems posted by commercial R&D laboratories, finding that openness is an effective problem-solving strategy. Opening up problems to a diverse field, termed 'broadcast search', led to approximately 30% of challenges being solved, which internal corporate laboratories had failed to solve previously. The study establishes the importance of "marginality": solvers from different fields to the problem domain were the most likely to create winning solutions, applying novel perspectives that experts had overlooked.

Lakhani, K. R., Boudreau, K. J., Loh, P.-R., Backstrom, L., Baldwin, C., Lonstein, E., Lydon, M., MacCormack, A., Arnaout, R. A., & Guinan, E. C. (2013). Prize-based contests can provide solutions to computational biology problems. Nature Biotechnology, 31(2), 108–111.

This study focused on a contest to develop algorithms for analysing immune system data. The competition generated solutions that outperformed existing methods used by the US National Institutes of Health (NIH) and Harvard Medical School. The contest successfully attracted a diverse pool of innovators, who introduced 89 new computational approaches. Open competitions can rapidly advance the state of the art in complex scientific fields, like computational biology, by helping to translate problems into general terms that non-domain experts can solve.

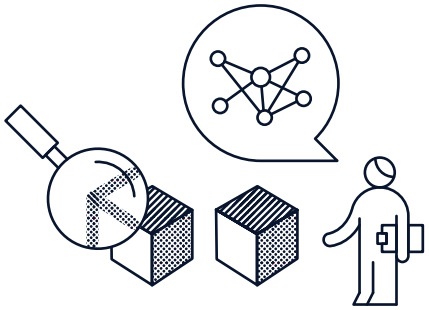
Moser, P., & Nicholas, T. (2013). Prizes, publicity and patents: Non-monetary awards as a mechanism to encourage innovation. The Journal of Industrial Economics, 61(3), 763–788

Using data from the 1851 Crystal Palace Exhibition, this paper investigates how non-monetary awards affect

innovation. It finds that technologies that won commemorative medals saw a 40% increase in subsequent patenting activity compared to non-winning entries. Publicity was seen as the primary driver of this effect, as simply highlighting a promising area of research can attract additional innovators to the field, which boosts aggregate innovation even without financial rewards.

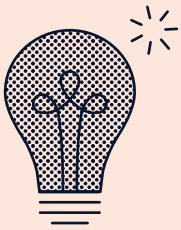
Sigurdson, K. (2021). [PhD Thesis focusing on DARPA Grand Challenge After-Effects]

This doctoral study focuses on the 2005 DARPA Grand Challenge for autonomous vehicles, examining the long-term effects of inducement prizes on researcher behaviour. Key findings included prize participation leading to a sustained 31% increase in new research collaborations, particularly across disciplinary boundaries. The prize helped identify and validate specific breakthrough technologies (such as the Kalman filter). Prizes can be instrumental in resolving uncertainty about which technical approaches are the most viable, and help in shaping the field trajectory.



9 Murray, F., Stern, S., Campbell, G., & MacCormack, A. (2012). Grand Innovation Prizes: A theoretical, normative, and empirical evaluation. *Research Policy*, 41(10), 1779–1792

Key points



- Grand innovation prizes (GIP) are large financial prizes for solving a significant goal, where the path to success is unknown in advance. The problem typically requires a breakthrough solution.
- Highlights a major gap between what economic theory suggests about prizes and the complex reality of how GIPs operate in practice. This especially applies to prize design, incentives, and programme governance.
- GIPs often allow innovators to retain IP rights while receiving a cash prize. The assumption that the prize incentive is solely monetary is incorrect; participants are driven by a broader range of incentives like media attention, reputation, and capacity building.
- The management, governance and administration of GIPs are crucial but often overlooked issues, leading to discrepancies between expected outcomes and reality.

Intro

Introduction

Traditional innovation mechanisms, such as patents and government procurement contracts, can be ineffective when addressing grand social challenges. Patents can provide insufficient incentive because the innovator is unable to capture the full societal value of the solution, while procurement contracts can limit the experimentation and exploration.

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This study provides an evaluation of a major GIP, the Progressive Automotive Insurance X PRIZE (PIAXP), which offered $10 million for an energy efficient vehicle. The study compares the theoretical claims made about GIPs against the reality of the competition, highlighting any divergence and identifying a roadmap for future innovation policy.

Key findings and conclusions

The study developed an evaluation framework based on three dimensions: objectives, design, and performance. It identifies three areas of divergence between theory/ policy and reality. Defining the technical specifications and winning criteria for a GIP is highly complex. Whilst theory assumes that the solution should be easily defined, the reality reveals the practical challenges of specifying the problem statement, potential goal creep and unexpected changes during the programme.

Economic theory also largely assumes that the prize incentive is determined entirely by the financial reward. In reality, GIPs often allow innovators to retain IP rights, creating a hybrid system. Participants are motivated by a wider set of incentives than money, including media attention, reputation, and skills / knowledge. Finally, the study found that the administration and ongoing governance of GIPs present challenges that are often overlooked. Accordingly, GIPs are not simple incentive mechanisms but complex organisational arrangements, which have to manage issues like the appearance of bias and the difficulty of managing iterative rule changes. GIPs often need to integrate multiple, sometimes conflicting, objectives. For the auto prize, designers had to balance measurable criteria (e.g., 100 MPGe efficiency) with unmeasurable criteria (e.g., consumer desirability and manufacturability). This complexity means that prize specifications are hard to finalise and are often revised

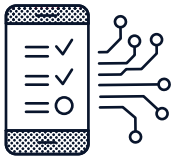
during the competition. This is an issue not accounted for by theory, yet is seemingly critical to successful prize management in practice.

Analysis – prizes as complex institutional mechanisms

The study provides a practical blueprint for prize design, putting a clear emphasis on process and context. The evaluative framework (objectives, design, and performance) has provided a foundation for subsequent research. It has also helped to shift the discussion on prizes beyond economic theory to the realities of delivery and implementation.

The study provides an evidence-base for understanding incentives, including the viability of hybrid mechanisms that combine cash rewards and IP rights. GIPs work by integrating a complex range of non-financial incentives, including media attention, learning, and credibility. This focus on communications and media buzz is essential for maximising leverage of R&D funding. GIPs are intended to maximise effort, not efficiency. In the study, the competition attracted a large number of participants, who collectively spent significantly more on R&D than the eventual prize purse.

The divergence over governance is a critical policy insight. Since the solution path for GIPs is frequently unknown in advance, prizes require flexibility and adaptability. The iterative and adaptive management often required during the competition introduces risks of perceived bias and complexity. Prize administration and governance, therefore, is a nuanced skill that requires careful institutional thought and learning. The study notes the importance of staged design in 'activating' the range of prize incentives, including facilitating media coverage, community building, and networking opportunities throughout the competition lifecycle.



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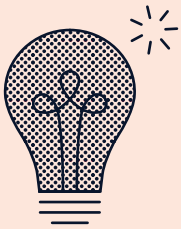
Williams, H. (2012). Innovation Inducement Prizes: Connecting Research to Policy. *Journal of Policy Analysis and Management*, 31(3), 752–776

Key points

- Current policy views prizes as a complementary tool to patents that overcome specific market failures.
- The social value of an innovation is driven by its price and accessibility. Prize designs benefit from mechanisms like market tests or price caps, to help the resulting technology be widely adopted.
- Effective prizes require policymakers to define clear, specific goals in advance, making them best suited for targeted technological challenges. Prizes are less suited for basic, fundamental research or serendipitous discoveries.
- Successful prizes often have multiple goals, such as encouraging wide consumer adoption or placing technology in the public domain to enable cumulative innovation.
- Policy design needs to account for non-financial benefits, such as reputation, media attention, and learning opportunities, as these are key motivations for entrants and help spur innovation activity.



Intro

Introduction

The US federal government clarified the process for federal agencies to offer challenge prizes via the America COMPETES Reauthorization Act of 2010. Subsequently, interest increased in how to effectively implement prizes. This paper by Williams addressed two gaps in the existing literature to help support this policy shift. Firstly, it summarises existing academic research, particularly

from economics, to draw practical lessons relevant to the types of innovation prizes that federal agencies might use – primarily those that supplement existing systems like patents. Secondly, it highlights the issue of how to evaluate the success or failure of innovation inducement prizes.

Main findings and conclusions

Williams argues that prize effectiveness is dependent not just on whether the solution is developed, but also on how the prize funder manages three often-overlooked goals. Prizes should be designed to spur the development of a product capable of being used at scale, rather than simply rewarding a demonstration project (such as the Ansari X Prize). For consumer-facing technologies, prize design should actively minimise price distortions and subsequent inefficiency (deadweight loss). Williams proposes mechanisms that link payment to metrics of adoption, such as AMCs which subsidise the price of a solution. Lastly, prizes can be structured to place the end technology in the public domain (e.g., patent buyouts). This is critical, as empirical evidence suggests that intellectual property rights can sometimes hinder subsequent cumulative research and innovation.

Analysis – insights for innovation policy

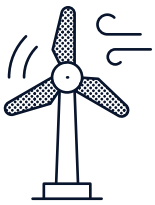
For public policy, Williams' paper creates an intersection between the sometimes abstract academic theory and the practical need for effective government innovation policy. Williams moves the policy discussion beyond debates over whether prizes should replace patents, focusing instead on how prizes can effectively supplement existing institutions.

the how to

Williams considers the fundamental evaluation problem of prizes. Policymakers often have to rely on anecdotal success stories (e.g., the Longitude Prize), but true policy guidance requires demonstrating additionality. This requires proving that the innovation would not have occurred. or occurred as quickly or efficiently, without the prize. Williams advocates for policymakers embedding rigorous monitoring and evaluation frameworks from the start, prioritising methods that can credibly estimate the counterfactual. She identifies the potential of field experiments for this purpose. Without more rigorous evaluation, resources could be misallocated based on assumptions rather than evidence.

Economic theory often models the prize incentive simply as the financial reward. Williams emphasises that, in practice, entrants are motivated by a much broader range of incentives that justify the investment of their resources, even if this means they spend more than the prize money itself. Subsequently, when designing a prize, funders should strategically maximise non-financial incentives that are particularly salient to participants, such as publicity, enhanced credibility, reputation, and opportunities for networking or skill development. These incentives are particularly to unconventional entrants.

The paper clarifies that design choices dictate whether a prize leads to a demonstration project or a viable solution ready for wide-scale use. Mechanisms like AMCs can link the reward to a subsequent market test, as a viable way to ensure the desired technology is both developed and capable of being used at scale. Accordingly, when the objective is to solve a market failure, such as inducing technologies where the social value exceeds the private value, policymakers should consider structuring the prize reward to be contingent on uptake or market performance, rather than solely on initial technical achievement.



Other notable papers

Kalil, T.. (2006). Prizes for Technological Innovation

Kalil argues that inducement prizes are an under-utilised policy tool that complement, rather than replace, traditional grants and contracts. Prizes have the ability to attract 'non-traditional performers' who might not work with the government otherwise, and they are efficient mechanisms for shifting financial risk from the funder to the innovator. Kalil proposes specific areas for greater use of prizes, such as space exploration and vaccines, advising that they work best when the goal can be defined concretely in advance, but the technical method for achieving it is unknown or speculative.

Khan, B. Z. (2015). Inventing prizes: A historical perspective on innovation awards and technology policy. Business History Review, 89(4), 631–660.

Khan offers a critical historical analysis, suggesting that the evolution of innovation prizes over three centuries provides a "cautionary tale". By reviewing data from the 18th and 19th centuries, Khan argues that the administration of prizes has suffered from arbitrary decision-making, bias, and a lack of transparency compared to more market-oriented systems like patents. While prizes may be effective in cases of market failure, they generally lack the efficiency of mechanisms that decentralise judgements on value and price.

McKinsey & Company (2009). 'And the winner is . . .' Capturing the promise of philanthropic prizes. Sydney, Australia: McKinsey & Company.

Documents the renaissance in prizes and introduces a taxonomy of six prize archetypes – such as "market stimulation" and "point solution" prizes – to help funders match the right type to their specific problem. Effective prizes require a clear objective, a large pool of potential

innovators, and competitors willing to bear risk. The successful execution of prizes relies on post-prize activities to ensure solutions scale and achieve lasting social impact.

National Academy of Engineering (NAE) (1999). Concerning Federally Sponsored Inducement Prizes in Engineering and Science. Washington, DC: National Academies Press.

Critical report in renewing interest in inducement prizes. Recommended that Congress encourage federal agencies to experiment with prizes as a complement to traditional R&D mechanisms. Prizes can attract diverse talent and stimulate interest beyond the usual participants. Prize rules must be transparent and fair, and agencies should have flexibility in design, including the authority to partner with the private sector for funding and administration.

National Research Council (NRC) (2007). Innovation Inducement Prizes at the National Science Foundation. Washington, DC: The National Academies Press.

Provides a blueprint for the National Science Foundation to implement an experimental prize programme. It distinguishes between first-past-the-post competitions, which reward the first to meet a metric, and best-in-class competitions, which reward the best performance within a timeframe. Prizes require active governance and should focus on "objectively measurable outcomes" to be seen as credible. Prizes are recommended for targeting high-risk research and attracting diverse participants, while advising that the government should generally not retain IP rights.

11 Conclusion

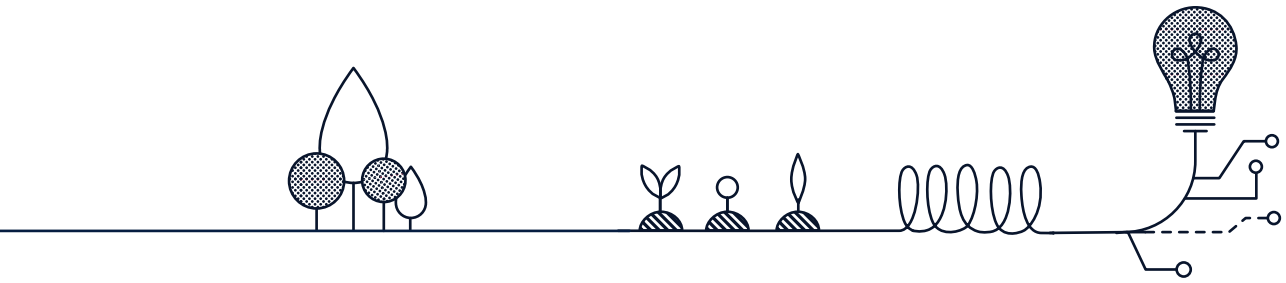
The ten papers in this collection show the shift in the debate on prizes. The studies in the foundational economics category share a common vocabulary and key concepts. But they offer unique contributions in helping track the evolution of how economists have come to understand and think about innovation funding. For a long time, economists argued about whether prizes were better than patents or grants. The evidence summarised here highlights the consensus in the literature now; prizes are a complementary tool to patents or grants, with different impacts. Awareness of the economic theory and related assumptions helps to understand the issues that prizes are designed to address.

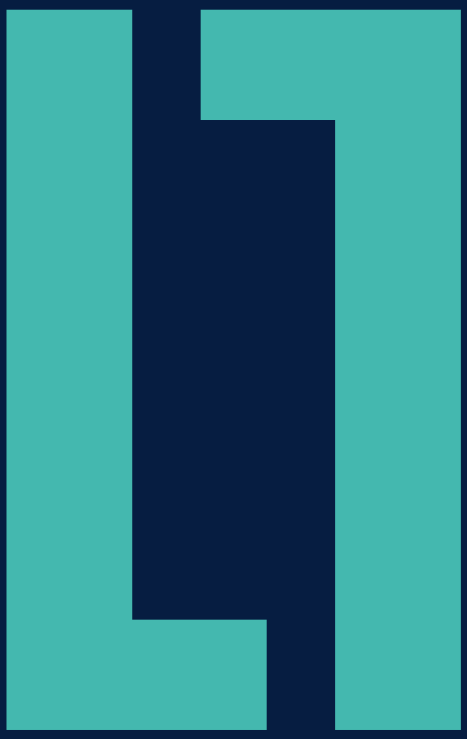
Push mechanisms like grants pay for effort, while pull mechanisms like prizes pay for results. Patents limit access solutions to recover costs, while prizes can open access and still adequately reward the innovator. When used correctly, prizes shift the risk of failure away from the funder and onto the innovator, who is better placed to assess and manage that risk. Prizes are also an effective tool for attracting unusual suspects, who might not otherwise engage in more traditional funding methods. The what works category looks at these key developments in the evidence on prizes, explaining why innovators invest resources into a competition, how prizes deliver long-term value, and how to design the problem and prize structure depending on programme aims.

The literature, though, cautions against viewing prizes as a simple fix. A prize is not a passive instrument, where you can simply publish a problem statement and wait for a breakthrough. Successful prizes require active management, relying on good governance and adaptable delivery. The design and governance category consider key aspects of the programme lifecycle, outlining the difficulties in setting rules and governing a prize. It sets out a logic for policymakers to help ensure the prize is targeted correctly and evaluated rigorously.

This collection summarises core ideas and essential thinking from the literature to support the effective use of prizes.

Innovation is inherently uncertain. Traditional funding models try to manage this uncertainty by picking winners in advance. Challenge prizes manage it by letting the winners pick themselves. This collection summarises core ideas and essential thinking from the literature to support the effective use of prizes. For policymakers, funders and wider stakeholders, it hopefully provides lessons to support the design of funding mechanisms that deliver on impact.





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